TABLE 5.4 ***Recommended Repetitive Member Factors for Dimension Lumber Used in Framing Systems***[1,2]

Application	Recommended C_r Value	References
Two adjacent members sharing load[3]	1.1 to 1.2	AF&PA,1996b HUD, 1999
Three adjacent members sharing load[3]	1.2 to 1.3	ASAE, 1997
Four or more adjacent members sharing load[3]	1.3 to 1.4	ASAE, 1997
Three or more members spaced not more than 24 inches on center with suitable surfacing to distribute loads to adjacent members (i.e., decking, panels, boards, etc.)[4]	1.15	NDS
Wall framing (studs) of three or more members spaced not more than 24 inches on center with minimum 3/8-inch-thick wood structural panel sheathing on one side and 1/2-inch thick gypsum board on the other side[5]	1.5–2x4 or smaller 1.35–2x6 1.25–2x8 1.2–2x10	AF&PA, 1996b SBCCI, 1999 Polensek, 1975

Notes:
[1]NDS recommends a C_r value of 1.15 only as shown in the table. The other values in the table were obtained from various codes, standards, and research reports as indicated.
[2]Dimension lumber bending members are to be parallel in orientation to each other, continuous (i.e., not spliced), and of the same species, grade, and size. The applicable sizes of dimension lumber range from 2x4 to 2x12.
[3]C_r values are given as a range and are applicable to built-up columns and beams formed of continuous members with the strong-axis of all members oriented identically. In general, a larger value of C_r should be used for dimension lumber materials that have a greater variability in strength (i.e., the more variability in strength of individual members the greater the benefit realized in forming a built-up member relative to the individual member strength). For example, a two-ply built-up member of No. 2 grade (visually graded) dimension lumber may qualify for use of a C_r value of 1.2 whereas a two-ply member of No. 1 dense or mechanically graded lumber may qualify for a C_r value of 1.1. The individual members should be adequately attached to one another or the load introduced to the built-up member such that the individual members act as a unit (i.e., all members deflect equally) in resisting the bending load. For built-up bending members with non-continuous plys (i.e., splices), refer to ASAE EP 559 (ASAE, 1997). For built-up columns subject to weak axis bending load or buckling, refer to ASAE EP 559 and NDS•15.3.
[4]Refer to NDS•4.3.4 and the NDS *Commentary* for additional guidance on the use of the 1.15 repetitive member factor.
[5]The C_r values are based on wood structural panel attachment to wall framing using 8d common nails spaced at 12 inches on center. For fasteners of a smaller diameter, multiply the C_r values by the ratio of the nail diameter to that of an 8d common nail (0.131 inch diameter). The reduction factor applied to C_r need not be less than 0.75 and the resulting value of C_r should not be adjusted to less than 1.15. Doubling the nailing (i.e., decreasing the fastener spacing by one-half) can increase the C_r value by 16 percent (Polensek, 1975).

With the exception of the 1.15 repetitive member factor, the NDS does not currently recognize the values in Table 5.4. Therefore, the values in Table 5.4 are provided for use by the designer as an “alternative” method based on various sources of technical information including certain standards, code recognized guidelines, and research studies. For more information on system effects, consult the following sample of references:

"Structural Performance of Light-Frame Truss-Roof Assemblies" (Wolfe, 1996).

“Performance of Light-Frame Redundant Assemblies” (Wolfe, 1990).

“Reliability of Wood Systems Subjected to Stochastic Live Loads” (Rosowsky and Ellingwood, 1992).

“System Effects in Wood Assemblies” (Douglas and Line, 1996).

Design Requirements and Bending Properties for Mechanically Laminated Columns (EP 559) (ASAE, 1997).

Rational Design Procedure for Wood Stud Walls Under Bending and Compression Loads (Polensek, 1975).

Stress and Deflection Reduction in 2x4 Studs Spaced 24 Inches On Center Due to the Addition of Interior and Exterior Surfacings (NAHBRF, 1974).

Structural Reliability Analysis of Wood Load Sharing Systems (Bonnicksen and Suddarth, 1965).

System Performance of Wood Header Assemblies (HUD, 1999).

Wall & Floor Systems: Design and Performance of Light-Frame Structures (FPRS, 1983).

5.2.4.3 Horizontal Shear Factor (C_H)

Given that lumber does not dry uniformly, it is subject to warping, checking, and splitting, all of which reduce the strength of a member. The horizontal stress values in the NDS-S conservatively account for any checks and splits that may form during the seasoning process and, as in the worst-case values, assume substantial horizontal splits in all wood members. Although a horizontal split may occur in some members, all members in a repetitive member system rarely experience such splits. Therefore, a C_H of greater than 1.0 should typically apply when repetitive framing or built-up members are used. For members with no splits C_H equals 2.0.

In addition, future allowable horizontal shear values will be increased by a factor of 2 or more because of a recent change in the applicable standard regarding assignment of strength properties. The change is a result of removing a conservative adjustment to the test data whereby a 50 percent reduction for checks and splits was applied in addition to a 4/9 stress concentration factor as described in Section 5.2.3. As an interim solution, a shear adjustment factor, C_H, of 2.0 should therefore apply to all designs that use horizontal shear values in 1997 and earlier editions of the NDS. As shown in Table 5.2, the C_H factor applies only to the allowable horizontal shear stress, F_v. As an interim consideration regarding horizontal shear at notches and connections in members, a C_H value of 1.5 is recommended for use with provisions in NDS•3.4.4 and 3.4.5 for dimension lumber only.

5.2.4.4 Size Factor (C_F)

Tabulated design values in the NDS-S are based on testing conducted on members of certain sizes. The specified depth for dimension lumber members subjected to testing is 12 inches for No. 3 or better, 6 inches for stud-grade members, and 4 inches for construction-, standard- or utility-grade members (i.e., C_F=1.0).

The size of a member affects unit strength because of the member's relationship to the likelihood of naturally occurring defects in the material.